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SANITARY COMMISSION.  
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REPORT

OF A

COMMITTEE OF THE ASSOCIATE MEDICAL MEMBERS OF  
THE SANITARY COMMISSION,

ON THE SUBJECT OF

AMPUTATIONS THROUGH THE FOOT,  
AND AT THE ANKLE-JOINT.

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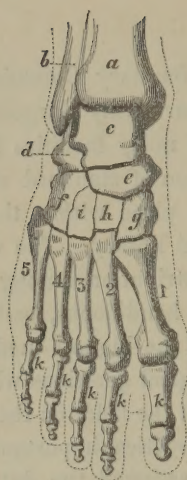
THE attention of the Sanitary Commission has been directed to the fact, that most of our Army Surgeons, now in the field, are unavoidably deprived of many facilities they have heretofore enjoyed for the consultation of standard medical authorities. It is obviously impossible to place within their reach anything that can be termed a medical library. The only remedy seems to be the preparation and distribution among the medical staff, of a series of brief essays or hand-books, embodying, in a condensed form, the conclusions of the highest medical authorities in regard to those medical and surgical questions which are likely to present themselves to surgeons in the field, on the largest scale, and which are, therefore, of chief practical importance.

The Commission has assigned the duty of preparing papers on several subjects of this nature, to certain of its associate members, in our principal cities, belonging to the medical profession, whose names are the best evidence of their fitness for the duty.

The following paper on "Amputations through the foot and at the ankle joint," belongs to this series, and is respectfully recommended by the Commission to the medical officers of our army now in the field.

FRED. LAW OLMSTED,  
*Secretary.*

WASHINGTON, DEC. 6th, 1861.



## BONES OF THE FOOT AND ANKLE-JOINT.

### SURGICAL ANATOMY.

*a* and *b*, Inferior Extremity of the Tibia and Fibula; *c*, Astragalus; *d*, Os Calcis; *e*, Scaphoid; *f*, Cuboid; *g*, Internal Cuneiform; *h*, Middle Cuneiform; *i*, External Cuneiform; 1, 2, 3, 4, and 5, First, Second, Third, Fourth, and Fifth Metatarsal Bones; *k*, *k*, *k*, *k*, *k*, Phalanges of the Toes

## REPORT.

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It is proposed in this paper to consider briefly those operations in the region of the foot which are generally regarded as conservative. They are all undertaken with a view either to preserve the largest extent of the extremity possible for subsequent unaided service, or to adapt a stump that affords the best medium for mechanical appliances.

### PRESERVATION OF INDIVIDUAL TOES.

It is always desirable to preserve as many of the phalanges as possible. If the injury is of such a nature as to require the sacrifice of all but one toe, this should be preserved. The support which is given to the foot in the mechanism of progression, by even the small toe alone, is sufficient to warrant its preservation. Especially is it important to save the great toe, which forms so considerable a part of the foot.

### AMPUTATION OF THE METATARSO-PHALANGEAL ARTICULATION.

When the injury requires the sacrifice of all the toes, the surgeon should, if the soft parts permit, remove them at their articulation with the metacarpal bones. The resulting extremity will be extremely serviceable without artificial aid.

*Operation.*—1st. The operator, grasping all the toes in his left hand, makes, with a narrow knife, a semi-circular incision, extending (for the left foot, and *vice versa*) from the internal border of the first metatarsal bone, to the external border of the



fifth, in front of the articulation of the toes with the metatarsus. 2d. The articulations are opened in succession with the point of the knife, and their ligaments divided. 3d. The knife is then carried behind the phalanges for the purpose of cutting out a semi-circular flap from the plantar surface of the foot.—*Lisfranc's Method in Bernard and Huette.*

#### EXCISION OF INDIVIDUAL METACARPAL BONES.

It occasionally happens that the local injury is of such a nature that by careful dissection the individual metacarpal bones may be removed, and the remainder of the foot be preserved. This is always preferable to any more considerable mutilation of the foot, and should not on any account be overlooked.

#### AMPUTATION AT THE TARSO-METATARSAL ARTICULATION.

If the injury involves so much of the extremity of the foot as to raise the question of amputation at a point higher than those already indicated, the surgeon should make every exertion to save the tarsus entire. If the soft parts allow it, this can be accomplished by amputation at the tarso-metatarsal articulation. The following description of the operation is condensed from Bernard and Huette:—

*To recognise the Articulation.*—1st. On the inner side of the foot carry the finger backward along the inner border of the metatarsal bone until a projection is encountered, one or two lines beyond; this is the articulation, situated in a depression between the two projections. The articulation may also be found just one inch anterior to the prominence of the scaphoid bone. 2d. On the outer side follow the external border of the fifth metatarsal bone, until the prominence at its proximal extremity is recognised; the articulation lies immediately behind it; in some instances, the head of the metatarsal bone projects a trifle beyond the articulation.

*Modes of Operating.*—1st. The patient is placed upon his back, and the foot rotated moderately inwards. The surgeon recognises the exact situation of the articulation by the rules already laid down, and then grasps, with the palm of his left hand, the sole of the foot, his thumb being placed on the outer side of the proximal end of the fifth metatarsal bone, and the index finger at the internal extremity of the articulation. He then makes a semi-lunar incision with its convexity looking downwards, from without inwards, across the dorsum of the foot, passing about half an inch below the articulation, and extending from one of its extremities to the other down to the bones.

2d. The surgeon divides, with the point of his knife, the dorsal ligaments, carrying it along the line of the articulation from without inwards, as already indicated, and recollecting that the articulation of the second metatarsal lies a third of an inch posterior to the others.

3d. The mortise in which the head of the second metatarsal is inclosed remains to be opened. This is effected by introducing the point of the knife between the internal cuneiform and the head of the first metatarsal bone, its edge being turned upwards, and making an angle of  $45^{\circ}$  with the axis of the foot. The knife is then carried up to a right angle, its point traversing the whole of the inner surface of the mortise, in order to insure the division of the interosseous ligament; it is then withdrawn, and applied to the external surface of the mortise.

4th. When this has been accomplished, pressure is made upon the metatarsus to separate the articular surfaces, and their remaining ligamentous attachments are successively divided, especially those on the plantar aspect of the articulation, so that the knife may be carried readily beneath the heads of the metatarsal bones, and the operation is then finished by cutting out a flap from the sole of the foot, which should be somewhat larger at its internal than at its external part.\*

\* The operation above described is generally known in this country as *Lisfranc's*

AMPUTATION AT THE MEDIO-TARSAL ARTICULATION. (CHOPART'S  
OPERATION.)

*To recognise the Articulation.* (Condensed from Bernard and Huette.)—The articulation at the middle of the tarsus is formed by the astragalus and the os calcis behind, and by the cuboid and scaphoid in front; the inter-articular line which crosses the foot transversely resembles the italic  $\infty$  of which the anterior convexity is internal and its posterior convexity external. The internal extremity of the articulation is just one inch in front of the internal malleolus, and two lines and a half behind the tuberosity of the scaphoid. The external extremity is half an inch behind the projection formed by the head of the fifth metatarsal bone. It corresponds with a prominence on the external surface of the cuboid bone, which is situated just one inch in front of the external malleolus. The centre of the articulation lies immediately in front of the head of the astragalus, which can be made to project by forcibly extending the foot. On the outside of this prominence is a depression sensible to the touch, lying between the astragalus, the cuboid, and the os calcis; the articulation is immediately in front of this.

*Rules in Operating.*—1st. The exact position of the articulation having been recognised by the means above indicated, the surgeon grasps the foot with his left hand, its sole being placed in his palm, his thumb upon the external extremity of the articulation, and the index finger upon the tuberosity of the scaphoid bone; 2d. The knife is then to be carried across the dorsum of the foot from the thumb towards the index finger, making a semi-circular incision which descends about half an inch below the line of the articulation; 3d. After the retraction of the integuments, divide the tendons which remain uncut and open the articulation, bearing in mind the varying obliquity

operation on the foot, and it is distinguished by this title from Hey's operation through the metatarsus.



of the articular surfaces as already indicated, and also to divide thoroughly the fibrous bands connecting the scaphoid and astragalus before attempting to enter the joint, as the thin edge of the scaphoid juts over the latter in some degree; 4th. The articulation being entirely laid open, and all its ligaments freely divided, pass the flat of the blade behind the bones, and having brought up the end of the foot into its natural position, cut out a flap from its plantar surface, which should extend beyond the sesamoid bones in order to possess sufficient length; the knife should graze the bones in making the flap, care being taken to avoid the projections of the scaphoid, cuboid, and first and fifth metatarsals.

#### AMPUTATION AT THE ANKLE JOINT.

Amputation at the ankle joint was performed with very indifferent success by the older surgeons. The failure was due rather to the inutility of the stump, than to the mortality after the operation. It was their invariable practice to make the flaps from the tissues about the ankle, and, with but rare exceptions, they left the malleoli undisturbed. The first difficulty which they experienced was in closing the wound over the projecting malleoli, and the second was the protrusion of these processes through the meagre covering of the stump, when the patient began to use his limb. Unfavorable as were the circumstances attending the early methods of performing this operation, still, many cases are on record in which a useful limb was obtained, due, doubtless, to the entire or partial absorption of the malleoli. Amputation at the ankle joint did not, therefore, obtain a place among the legitimate operations of the earlier surgeons. It may fairly be questioned if operative surgery has in any instance made a more important advance toward the realization of its humane purposes of saving life and restoring useless limbs than in this single particular of amputation at the ankle joint. Previously to 1843, in all affections of the foot involving its removal, amputation

was performed through the leg. The mortality after this operation, always considerable, varies with circumstances. In the Parisian hospitals it has been estimated as high as fifty per cent., even when performed for chronic disease, a condition most favorable to success. American hospitals give thirty-seven per cent., and English hospitals nearly twenty per cent.; a fair average of the mortality of this operation, may be put at twenty-five per cent. In 1850, Mr. Syme stated (*Monthly Jour.*) that he had performed amputation at the ankle between thirty and forty times, with the loss of but a single patient, and in this case the unfortunate result was not due to the operation. More recently he remarks, "the operation itself I believe to be as free from risk as the removal of a finger or toe."

There are now two principal methods of amputation at the ankle joint known respectively by their projectors as Syme's and Pirogoff's operations. The relative merits of these operations will be more easily appreciated by describing the methods pursued and grouping the facts which experience has thus far accumulated.

#### SYME'S METHOD.

*Operation.*—The foot being placed at a right angle to the leg, a line drawn from the centre of one malleolus to that of the other, directly across the sole of the foot, will show the proper extent of the posterior flap. The knife should be entered close up to the fibular malleolus, and carried to a point on the same level of the opposite side, which will be a little below the tibial malleolus. The anterior incision should join the two points just mentioned at an angle of  $45^{\circ}$ , to the sole of the foot and along the axis of the leg. In dissecting the posterior flap, the operator should place the fingers of his left hand upon the heel, while the thumb rests upon the edge of the integuments, and then cut between the nail of the thumb and tuberosity of the os calcis, so as to avoid lacerating the soft parts, which he, at the same time, gently but steadily presses back until he exposes and divides the tendo Achillis. The foot should be disarticu-

lated before the malleolar projections are removed, which it is always proper to do, and which may be most easily effected by passing a knife around the exposed extremities of the bones, and then sawing off a thin slice of the tibia connecting the two processes.\* Mr. Syne directs the articular surface of the tibia always to be removed. This, certainly, should be done, if the disease has attacked the part; but, if healthy, it seems to be unnecessary. In one of the writer's cases, the extremity of the tibia was removed, but without any apparent benefit as respects the result. The following wood-cuts, of reduced size,



taken from similar illustrations in the *Monthly Journal*, Feb. 1850, give a more correct idea of the line of incision than can any verbal description. It will be seen that they differ very materially from those given in text books. The principal

precaution to be observed, is in the dissection on the posterior part of the os calcis, in order not to wound the posterior tibial artery, and thus deprive the flap of its nourishment.

It is recommended by some surgeons to disarticulate before dissecting the posterior flap. This proceeding increases the liability to wound this vessel, nor does it facilitate the operation.



The artery may readily be avoided by keeping the edge of the knife constantly turned from the flap toward the bone. By this means also, the operator will not be liable to puncture the posterior flap—an accident which has occasionally occurred, but which does no harm.

\* SYME'S *Contributions to Surgery*.

## PIROGOFF'S METHOD.

*Operation.*—The following description of this method is taken from a London Medical Journal, and was translated from the author:—"I commence my incision close in front of the outer malleolus, carry it vertically downwards to the sole of the foot, then transversely across the sole, and lastly obliquely upwards to the inner malleolus, where I terminate it a couple of lines anterior to the malleolus. Thus all the soft parts are divided at once quite down to the os calcis. I now connect the outer and inner extremity of this first incision by a second semilunar incision, the convexity of which looks forward, carried a few lines anterior to the tibio-tarsal articulation. I cut through all the soft parts at once down to the bones, and then proceed to open the joint from the front, cutting through the lateral ligaments, and thus exarticulate the head of the astragalus. I now place a small narrow amputation saw obliquely upon the os calcis behind the astragalus, exactly upon the sustentaculum tali, and saw through the os calcis, so that the saw passes into the first incision through the soft parts. Saw carefully, or the anterior surface of the tendo Achillis, which is only covered by a layer of fat and a thin fibrous sheath, might be injured. I separate the short anterior flap from the two malleoli, and saw through them at the same time close to their base. I turn this flap forwards, and bring the cut surface of the os calcis in apposition with the articular surface of the tibia. If the latter be diseased it is sometimes necessary also to saw off from it a thin slice with the malleoli."

Pirogoff believes also that the tendons should not be cut off too short, in other words "not too near the spot where their synovial sheaths are cut through; their ends should rather project a little. If they are cut too short they conceal themselves in the fibrous canal, or what is worse, when the limb is moved they slip upwards out of their sheaths." He adds:—"I fear nothing so much as this, namely, when the belly of the muscle



contracts, and draws up the tendon divided, or half destroyed by suppuration, out of the sheath. I am convinced that the fixing of the tendons before and during the operation by methodical pressure, and the continuous maintenance of the limb in one and the same position by the plaster of Paris bandage, may contribute a great deal towards the successful result of these operations."

The following description of the several steps of the operation as more recently performed, is given by MR. CROFT (London *Lancet*, Feb. 6, 1858), one of the surgeons of the Dreadnought Hospital, where the operation had, at that date, been performed six times. He says:—

"The mode of operation, as performed by Mr. Busk, Mr. Tudor, and myself, is to grasp the projecting portion of the foot with the left hand, then to enter the point of the knife *immediately* behind the malleolus, and make a semi-circular incision in front of the point, terminating at a corresponding point behind the opposite malleolus; next, to carry the incision downward and slightly forwards to the edge of the sole of the foot, straight across the sole, and terminate it at the opposite malleolus, or the point at which the incision was commenced. Having disarticulated the foot, the soft parts are to be separated from around the os calcis in a line from the posterior margin of the upper articulating surface to the under edge of the articulating surface of the cuboid, and the mass in front of this line to be removed by the saw. The ends of the tibia and fibula are sawn off in the way usual in Syme's operation. During the process of separating the soft, or rather tough parts about the os calcis, care should be taken to keep the edge of the knife close to the bone, in order to avoid wounding the posterior tibial or plantar arteries. The portion of the os calcis left on the flap should be placed in contact with the end of the tibia, and if the saw has been entered well behind the calcaneo-astragaloid articulation, and brought out at the under margin of the calcaneo-cuboid articulation, the contact will be accurate. If the bones cannot be placed in accurate contact, thin slices of bone from the upper and back part of the portion of the os calcis should be removed by the saw until they can be adapted. The saw we prefer is Bigg and Milliken's modification of Butcher's Dublin saw."

## REMARKS.

In deciding upon the point of amputation, surgeons are very properly governed by the following simple rules:—

- 1st. The comparative danger of the operation; and
- 2nd, The comparative usefulness of the stump.

If there were two given points at which an amputation might be performed, no prudent surgeon would select the one having the largest mortality, unless the ultimate advantages were of the utmost importance to the usefulness or happiness of the patient. Of the operations on the foot which we have passed in review, it may be said that in all which involve the parts anterior to the medio-tarsal, or Chopart's amputation, these two conditions combine to determine the surgeon to save as much of the extremity as possible. The mortality of the operation diminishes and the usefulness of the limb increases in proportion to the amount preserved. There can be no doubt, therefore, that it is the duty of the operator to preserve as much of the anterior portion of the foot as possible.

But new and important questions arise when we attempt to decide upon the value of the three remaining operations by the rules proposed. With a view to a proper appreciation of the alleged advantages and disadvantages of these amputations, in order to arrive at correct conclusions as to their comparative merits, we present the following summary of opinions by surgical authorities.

*Chopart's Operation.*—Chopart's operation has now been practised nearly three-quarters of a century, and has been, during the whole period, the subject of severe criticism. On the one hand it is contended that the stump is entirely serviceable, that the operation is attended with slight mortality, and that by it an important portion of the foot is preserved. On the other, it is asserted that the stump is generally tender, very often affected with incurable ulcers, and, finally, that the extremity of the stump is liable to become the most depending

portion, and the cicatrix the point of support. Some attribute this tendency to retraction of the heel to the action of the feebly antagonized extensors of the foot, and others to the removal of one half of the arch of the foot. Whatever may be the explanation, it is certain that surgeons have constantly met with this position of the stump, and endeavor to remedy it. Within three years of its first introduction, Petit divided the tendo Achillis to relieve the defect, and this operation has often been repeated since.

Reports unfavorable to the operation have frequently been made by Surgical Authorities. In 1815 Villermé reported a score of cases in which the patients could walk well only from five months to two years after the operation. Bouvier recently read a paper before the Society of Surgery, Paris, in which he condemned Chopart's operation in strong terms. According to him, bad results almost invariably follow in time; these patients fill the hospitals of incurables; section of the tendon is only a temporary expedient, and the difficulty returns on its reunion; he therefore advised its rejection.

In reply to this communication, Chassaignac declared the amputation of Chopart to be an excellent operation, and referred to cases in which the patients walked well without division of the tendon, to others where the division of the tendon relieved the difficulty, and finally to some who walked freely upon the face of the stump itself. He thought the operation should not be rejected, but be perfected, since it was very safe; the division of the tendo Achillis is now very frequently practised, either immediately after the operation, or when the heel has been elevated and the cicatrix has become the most depending portion.

The opinions of the following well known authorities may be added:—Blandin asserts that he has met with retraction of the stump but once in eleven amputations. Velpeau did not meet with retraction in five cases, and regards it as an exceptional occurrence. Nélaton approves the operation, and thinks retrac-

tion may or may not take place ; if it occur, division of the tendo Achillis relieves it for a time at least. Mr. Fergusson and Mr. Cock, of London, have remedied this condition by division of the tendo Achillis, and do not consider it a valid objection. Mr. Syme, on the contrary, seems to reject Chopart's operation altogether. In some clinical remarks on a case upon which he was about to perform his operation, in 1852, he said, "There is extensive disease of the tarsus, not leaving room for the performance of Chopart's operation, even if I deemed it expedient, which I have long ceased to do, from conviction of its inferiority to that at the ankle, especially in regard to the protection afforded against relapse. In one year alone, I performed three secondary amputations at the ankle to remedy the sequelæ of Chopart's operation." Prof. Gross expresses himself strongly in favor of the operation. He says :—"Of the utility of this procedure, in the class of cases under consideration, there can no longer be any doubt ; I have employed it several times in my own practice, and I have seen it repeatedly executed by others, and in every instance that has come within my notice, the result has been most satisfactory."

*Syme's Operation.*—Syme's method is now an accepted operation with the surgeons of Great Britain. Mr. Fergusson, who had operated eight times, says :—"In so far as I can judge, it is one of the greatest improvements in modern surgery as regards the subject of amputation." Mr. Erichsen remarks that it "constitutes one of the greatest improvements of recent date in operative surgery, as by its performance amputation of the leg may often be avoided, and the patient being left with an exceedingly useful stump, the covering of which being ingeniously taken from the heel, constitutes an excellent basis of support." Mr. Quain thinks the operation "free from any valid objection, and, what is more important, the result in practice has been found to be good. A person who has undergone this operation is enabled to bear his whole weight upon



the end of the stump without inconvenience; and, on this account, the facility of progression is, with a proper apparatus, decidedly greater than when the amputation is performed at any higher part of the limb."

On the contrary, it is alleged against this operation—

1st. That it is *difficult and tedious*. But Mr. Syme states that he requires less time than a minute to perform it.

2d. That the *flap is liable to slough*. This, however, rarely takes place to any considerable extent. Mr. Syme says:—"That the flap may, and probably will still occasionally slough, is unhappily too true, but that this result is always owing to an error in the mode of performance, I think does not admit of any question. For as the integument being detached from its subjacent connexions, can derive nourishment only from the anastomosing vessels, it is evident that if scored crossways, instead of being separated by cutting parallel to the surface, the flap must lose its vitality."

3d. *That there is a necessary delay in the healing of the wound*. From recent statistics it appears that union is much more prompt, in a given number of cases in Syme's than in Chopart's amputation. Dr. Van Buren, of New York, has met with union by the first intention; in a case which recently came under the writer's observation, the patient bore her weight on the stump on the fifteenth day, union being at that date complete.

4th. *That the stump is sensitive, and hence not serviceable*. Mr. Syme remarks:—"Patients who had suffered the operation, were able to stand, walk, and even run, without any covering or protection of the stump; and a gentleman present, having had his attention accidentally directed, a few days before, to some boys who were amusing themselves on a slide in the street, discovered that one of them had undergone amputation at the ankle joint." Dr. VAN BUREN, of New York, states that a patient recently presented himself at the College clinic of the University Medical College, on whom Mr. Syme

performed his operation sixteen years ago, being the third person on whom the operation was performed, who stated that he had walked thirty miles in a day without inconvenience from his stump. We may add the following fact, which came under our own observation:—A man presented himself at Bellevue Hospital during the last winter, who had undergone amputation at the ankle joint, by DR. CARNOCHAN, a year or more previously. He was a book-peddler by occupation, and stated that he not unfrequently walked eight miles daily, without fatigue or inconvenience from his mutilated limb. He had but a very slight limp. He wore a short shoe, with the sole raised sufficiently to compensate for the loss of the foot. We may add that recent statistics show that but a single case is authenticated of a stump so sensitive as not to admit the weight of the body.

*Pirogoff's Operation.*—Pirogoff claims for his method of amputation the following advantages:—1. The tendo Achillis is not divided, and we avoid all the disadvantages connected with its injury. 2. It also follows that the base of the posterior flap is not thinner than its apex, while the skin on the base of the flap remains ununited with the fibrous sheath of the tendo Achillis. 3. The posterior flap is not cap-like, as in Syme's method, and its form is therefore less favorable to a collection of pus. 4. The leg after this operation appears an inch and a half (sometimes even more) longer than in the three other operations (Syme, Baudens, Roux), because the remnant of the os calcis left in the flap, as it unites with the inferior extremities of the tibia and fibula, lengthens them by an inch and a half, and, 5. Serves the patient as the point of support.

MR. CROFT furnishes the following account of the six cases occurring at the Dreadnought:—"Six times the operation has been performed, and in four instances with most perfect success; but in the two remaining death removed the subjects of operation before cure was completed—in the first instance by granular disease of the kidneys, and in the second instance by

secondary deposits of pus in various joints. In two of the six cases in which cure was completed, the operation was performed for the removal of scrofulous disease of the articulation between the tarsal bones; and in the two others the operation was for frost-bite of the anterior part of the foot. Progress towards health was marked by suppuration along the tendons of the *tibialis anticus* and *posticus*, and the peroneal tendons in each of the cases, but not by exfoliation of bone. The posterior part of the *os calcis* was united firmly with the tibia, generally in about three weeks; but in one instance—the last in which the operation was performed—union was good at the end of twelve days. I may here remark, that although the *os calcis* may be diseased at and about its articulation in instances of scrofulous disease of the joints of the tarsus, it is rarely that the posterior part is rendered too unhealthy to be made use of in the formation of a stump. The advantages of this operation over “Syme’s” (the only operation with which it can be compared) are, that it may be performed more rapidly as to time, leaves a more vascular flap, forms a longer stump, and produces a firmer pad for the subject to walk upon. Less time is occupied in the operation, for the somewhat troublesome dissection of the skin of the heel from the *os calcis* is avoided, and the *os calcis* sawn through instead. Greater vascularity of the flap is secured, for the plantar arteries are divided in the hollow of the foot. The length of the stump is a very important point; it is longer than in Syme’s operation, by the portion of the *os calcis* left on the flap, which should be quite one inch and a quarter. In the four instances mentioned, the difference in length between the foot operated upon and the sound foot, was never more than three eighths of an inch.”

MR. BUSK, of the same hospital, who has operated three times, says, “Greater facility and rapidity of execution; less disturbance of the natural relations of the parts which are to form the cushion of support; a solid instead of a hollow flap; and, lastly, a greater length of stump, amounting to at least one inch and

a half—are such recommendations as few will be found to deny, and against which nothing, so far as I can perceive, is to be opposed.”

In regard to the liability to non-union of the fragment of os calcis, we have the following testimony. Pirogoff says of his first three cases, “notwithstanding the suppuration and considerable gravitation of pus into the flap in the third case; notwithstanding the softness and fatty degeneration of the os calcis, which could be cut with the knife, in the second case; and lastly, notwithstanding the bleeding fungous excrescences which formed on the bones, also in the second case; still the remains of the os calcis united firmly with the tibia and fibula. Lastly, one of the cases, the third, proves that the exarticulation at the ankle joint after my method—at least in children and young people—may be undertaken even in cases of diseased ankle joint, provided disorganization has not extended too far over the soft parts about the articulation. In the boy in the second case, I found pus in the capsule during the operation, the cartilages softened and decayed, the ends of the bones also softened, and in a state of fatty degeneration, yet the result of the operation was most successful.”

Mr. Busk says:—“Some have feared that the section left of the calcaneum would not readily unite with the extremity of the tibia; but this fear is groundless. In the last operation performed by Mr. Tudor union was found to be quite firm on the twelfth day. . . . In my first case the man could support his whole weight on the stump within a fortnight.”

A correspondent of a London Medical Journal thus records an interview with Mr. Syme: “Mr. Syme spoke of it (Pirogoff’s operation) with much contempt, alleging that the retained extremity of the os calcis would, in the first place, be likely to act as a foreign body, and cause irritation, and that even if good union were obtained the limb would be too long to be useful. . . . I can only say that some of the best stumps that I have ever seen have been obtained by it, and that so far from the



portion of os calcis acting as a foreign body, it usually unites easily and firmly to the tibia. In London the operation has been performed by Mr. Ure of St. Mary's, by Mr. Simon of St. Thomas, by Messrs. Busk, Tudor, and Croft at the Dreadnought, and by Mr. Fergusson and Mr. Partridge in King's College; all of whom have, I believe, been, on the whole, well satisfied with its results. At the Glasgow Royal Infirmary, Dr. McGhee, the Medical Superintendent, showed me a case in which it had been performed seven weeks previously. The stump was just healed, and promised to be an excellent one. It was, I understood, the first case in Glasgow in which that operation had been adopted."

The objections generally raised to this operation, are thus summed up by Mr. Syme, in comparing it with his own method. He alleges that "this operation deprives *his* of all its advantages in the first place, by rendering it complicated instead of extremely simple; secondly, by making the stump too long; thirdly, by impairing its constitution; fourthly, by retaining a portion of the osseous tissue justly liable to the suspicion of relapse; and fifthly, by not being applicable to all cases requiring amputation at the ankle." The preceding opinions quoted from surgeons who have had experience in this operation, practically refute these objections. They all regard Pirogoff's operation as the more simple; the greater length of the limb is considered an advantage to the poor man who has no artificial limb; the stump is thought to be more sound and serviceable; the liability of the osseous portion of the flap to necrosis is denied; it is deemed applicable to all cases suitable for Syme's operation, provided only the posterior portion of the os calcis is not diseased.

Pirogoff's operation has now been performed upwards of twelve times by the surgeons of Great Britain; and all who have operated, have spoken favorably of it.

GENERAL APPRECIATION OF THE AMPUTATIONS OF CHOPART, SYME,  
AND PIROGOFF.

Taking the foregoing facts as the basis of an appreciation of the comparative merits of these several operations, with such suggestions from experience as may occur to us, we are prepared to determine their relative value, and definitively apply the rules in operative surgery already stated.

1st. *The Operation decided by Comparative Mortality.*—Statistics do not determine with sufficient accuracy the comparative mortality of these several amputations. It does not appear that the influence of the diseases or accidents for which amputation was undertaken, upon the mortality, is estimated in these summaries. Chopart's operation has always been regarded as attended with very little danger. In Mr. Syme's extensive experience in his own operation, the mortality is almost nominal. He states that he regards it as no more fatal than amputation of the finger; in 40 cases, he had but one death, and that was not fairly attributable to the operation. From our own observations we should not regard Syme's operation as any more fatal than Chopart's, in the same individual cases. Nor can we believe, if we attach proper importance to the opinions of the eminent surgeons who have practised Pirogoff's method, already brought forward, that independently of the co-existent disease or injury, this operation is more dangerous than either of the two preceding amputations. All speak with great confidence of its safety. If to the foregoing facts we add the additional consideration, that the danger in all these operations is for the most part the same, viz. the liability to suppurative inflammation in the sheaths of the divided tendons, we can but believe that the actual mortality from the three operations is not widely different. We may conclude, therefore, that—

*The comparative mortality of Chopart's, Syme's, and Pirogoff's amputations is too slight to influence the Surgeon in his selection but—*

2d. *The individual operation should be determined by the Serviceableness of the Stump.*—This question involves, according to previous rules in determining the point of election in amputations, the social condition of the patient. The poor man's and the rich man's leg have long decided the point of amputation of the lower extremity. This distinction is made in the belief that the poor man will either have no artificial appliance to his stump, or one of the rudest character, while the rich man will avail himself of the highest degree of art to compensate his loss. This question must always present itself to the military surgeon, if the rule remains valid, for in the ranks of every army we find, as in society at large, persons filling every grade of social position.

In our time, when mechanical surgery is doing so much to supply the maimed with serviceable limbs, and in this country, where public and private charity is so lavish in the relief of suffering, and the poorest may, by economy, accumulate wealth, the question may well be mooted if this old rule in operative surgery should longer govern the surgeon. Especially may we doubt its propriety, when the subject of the operation is under middle life. The instances are becoming more and more frequent where persons in humble circumstances, who have had a limb removed according to this rule, have subsequently been able to supply themselves with artificial aids, and have bitterly regretted that they have been deprived of the opportunity by the surgeon. It cannot be denied that in such cases the rule has operated to the serious disadvantage of the patient. We must conclude, therefore, that with American surgeons this rule should be modified thus :

*Under all circumstances, except where poverty and advanced age, and confirmed dissolute habits, so combine in the individual, as to render it certain that mechanical appliances would be of little service, give the patient the stump best adapted to the most useful artificial limb.*

The two following questions grow out of this conclusion :

1st. Of the three above-mentioned operations, which gives the most useful stump for progression without aid?

2d. Which affords the best stump for artificial appliances?

In regard to Chopart's amputation, it has been seen that the testimony of surgeons is very conflicting as to the usefulness of the stump. It cannot, we think, be denied, that it has frequently required subsequent interference, such as division of the tendo Achillis, a support under the anterior part of the stump, &c., in order to prevent such a degree of retraction of the heel as would bring the cicatrix to the most dependent part. Indeed, no one can examine the normal relations of the tarsal bones without being struck with the fact, that by this operation more than half of the anterior part of an arch is removed, leaving the remaining portion to sustain the entire weight which before belonged to the whole. It could scarcely result otherwise than that, in a well-formed foot, the posterior half of the arch would fall under the superincumbent weight. If we add to this, the constant elevation of the heel by the powerful and feebly antagonized muscle of the calf, we can only be surprised that in time every stump of this kind is not turned with its face downwards. And it must be admitted by the most ardent advocates of this operation that in some instances it has been found impossible to remedy these defects, and patients have remained permanently unable to bear their weight upon the stump.

It has been alleged, as already noted, that in Syme's operation the stump is often so tender that the patient cannot bear his weight upon it. Such an opinion would seem to be rather theoretical than practical. We do not know of any well-founded proofs that such a result follows. On the contrary, Mr. Syme's testimony, as we have already stated, coincides with our own experience, that the stumps are capable of great endurance. Of Pirogoff's operation we cannot speak as confidently, from want of sufficient evidence; but it will be seen in the preceding pages, that so far as we have obtained the opinions of those who have had the most experience, the stumps, when



firmly healed, are capable of sustaining any desirable degree of direct use. It must not be overlooked, however, that sinuses occasionally form, leading to carious bone, which long remain a serious drawback to the usefulness of the stump.

We are authorized in concluding:—

*That the stump after Syme's or Pirogoff's operation is the most serviceable, without artificial aid; preference being given to the former.*

The question of adapting artificial limbs to these several stumps mainly rests with those engaged in mechanical surgery. So far as we have been able to ascertain the facts, Syme's operation gives much the best stump for an artificial extremity. Although a foot can be supplied cheaply in Chopart's amputation, yet it but poorly remedies the defect, and does not improve the patient's power of walking. An artificial limb may be applied to Syme's stump, which both relieves deformity, and renders the patient's gait free from the slightest halt. The following opinion of an intelligent mechanical surgeon, of great experience, is worthy of notice:—

“Among the numerous instances of mutilated feet through the tarsus, which fall to our care for treatment, it is seldom that we are able to designate a perfectly satisfactory stump, one to be preferred to what might have been made of parts contiguous. Nine-tenths of the mutilations, as by Chopart, present one or more of the following diagnostics, to wit: *First*, of an insufficient covering; caries, more or less, of the remaining tarsal bones; ulceration of the surrounding soft parts, or that of a thin shining pellicle of covering, exceedingly susceptible, quickly inflamed, and abraded by the least exposure, which renders it hazardous or difficult to attempt the application of any substitute. *Second*, a total inability to flex the stump, and to preserve its normal position at a right angle with the line of the leg; a morbid contraction of the gastrocnemii muscles (without antagonism), and retraction of the heel; a pendent position of the end of the stump, and exposure of the cicatrix

to be pressed to the ground by the weight of the body, with its general inutility for walking. No possible advantage can be obtained by an amputation of the foot which involves in the sacrifice the greater portion of the tarsus, but what will be largely enhanced by a well-timed operation at the *ankle-joint*, after the mode of Mr. Syme: therefore, by every consideration of humanity and art, I am led to regard that site as the one which should be designated as the SECOND PLACE OF ELECTION."

We are not aware that any artificial limb has yet been devised for the stump after Pirogoff's amputation. We may add, that those skilled in the manufacture of artificial limbs consider this stump very poorly adapted for a useful mechanical contrivance.

We conclude:—

*That the stump after Syme's amputation is much better adapted for an artificial appliance than that resulting from either Chopart's or Pirogoff's operation.*

*After Treatment.*—The subsequent treatment of operations of the foot is of great importance, as regards their ultimate success. Although immediate union is always desirable, yet it is not always attainable, even under the most favorable circumstances, as where operations are performed in the immediate vicinity of lacerated wounds, as must frequently occur in attempts to save fragments of the foot. Union by granulation cannot be anticipated. In view of the liability of the wounds left after amputations through the foot, and the excision of bones, to suppuration, and the consequent dangers of pyæmia, the practice of leaving them open to heal by granulations is becoming more and more general. The process of cure proceeds more favorably in a given number of cases thus treated, than when the wound is at once closed; and the cicatrix which forms under these circumstances is both symmetrical and useful.

We deem it advisable also, in Syme's amputation, not to close the wound immediately. Owing to the constant oozing of blood in four cases performed in Bellevue Hospital the stump

was not dressed for several hours. The limb was placed in an elevated position, and cold water freely applied. The advantages of this delay were evident; the deep cavity formed by the extremity of the heel in the posterior flap contracted to a small size, which, with the complete cessation of the oozing of blood, removed the danger following its collection and disorganization in this situation. In every instance when the wound was dressed, the posterior flap was found as warm as the leg, and quite as sensitive to the prick of the needle, showing that its vascular and nervous supply was undiminished. The only other fact worthy of notice in the after treatment, was the daily injection of tepid water, and disinfecting fluids into the cavity of the stump while suppuration continued. By these means the internal surface of the wound was cleansed, and the process of granulation and adhesion promoted.

#### GENERAL CONCLUSIONS.

I. IN ALL AMPUTATIONS OF THE LOWER EXTREMITY, THE SURGEON SHOULD BE GOVERNED IN THE SELECTION OF THE POINT OF OPERATION AND THE METHOD TO BE ADOPTED—

1. BY THE MORTALITY OF THE OPERATIONS IN QUESTION;
2. BY THE ADAPTABILITY OF THE STUMP TO THE MOST SERVICEABLE ARTIFICIAL LIMBS.

II. IN ALL INJURIES OF THE FOOT, INVOLVING PARTS ANTERIOR TO THE MEDIO-TARSAL ARTICULATION, THE SURGEON SHOULD SACRIFICE AS LITTLE AS POSSIBLE OF THE STRUCTURES ESSENTIAL TO PROGRESSION. HE SHOULD PRESERVE

1. SINGLE PHALANGES, THE IMPORTANCE OF WHICH INCREASES FROM THE SMALL TO THE GREAT TOE;
2. THE METATARSUS, BY AMPUTATION OF THE PHALANGES, OR BY THE EXCISION OF INDIVIDUAL METACARPAL BONES;
3. THE TARSUS, BY AMPUTATION AT THE TARSO-METATARSAL ARTICULATION (HEY'S OR LISFRANC'S METHOD).

III. OF THE AMPUTATIONS THROUGH THE TARSUS OR AT THE ANKLE-JOINT,

PREFERENCE SHOULD BE GIVEN TO SYME'S OPERATION AS AFFORDING A MINIMUM MORTALITY, WITH A STUMP BEST ADAPTED TO AN ARTIFICIAL LIMB.

IV. IN THE AFTER TREATMENT OF THE AMPUTATIONS AND RESECTIONS ABOVE CONSIDERED, IT IS GOOD PRACTICE TO LEAVE THE WOUNDS OPEN TO HEAL BY GRANULATION.

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